View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NASA Technical Reports Server

"...in the interest of early and wide dissemination of Earth Resources Survey Program information and without liability for any use made thereof."

E7.3 10.437
CR-131231

ERTS DATA USER TYPE-1 PROGRESS REPORT FOR
JANUARY/FEBRUARY/MARCH 1973

Project Title/Objective: Relevance of ERTS to the State of Ohio

Proposal Number: MMC No. 87

Contract Number: NAS5-21782

BCL Subcontract Number: 72-17/G-1793

Principal Investigator: Dr. David C. Sweet

N73-20397
(E73-10437) RELEVANCE OF ERTS TO THE STATE OF OHIO Progress Report, Jan. - Mar. 1973 (Ohio Dept. of Economic and Community) 17 p HC $3.00 CSCL 08F
Unclas G3/13 00437

I. DATA COLLECTION

ERTS-1 data received from NASA during the present reporting period are summarized in Tables I and II. Included in these summaries are both black-and-white imagery and some parts of the color composite order placed previously. In addition to the imagery described in these tables, compatible computer tape data have been received for most of these same scenes.

Plans for data collection during the next reporting period are to conduct an aircraft underflight of the five Ohio study sites during the ERTS overpass of Ohio during the week of April 30. In addition, field ground-truth surveys of the Wooster extension branch sites are planned for this period. The Ohio EPA will be conducting studies of oil spills in Lake Erie which will be added to our data base for ERTS environmental studies.

II. DATA ANALYSIS

A. Data Analysis Laboratory

Additional improvements have been made in the Remote Sensing Applications Laboratory to further facilitate the analysis of ERTS-1 data. The most important one was the addition of a Spectral Data Model 25 viewer (Serial Number 1). The viewer displays 70-mm ERTS transparencies which may be

Original photography may be purchased from:
EROS Data Center
10th and Dakota Avenue
Sioux Falls, SD 57198

Details of illustrations in this document may be better studied on microfiche

17

TABLE I. COVERAGE AND QUALITY OF ERTS-1 DATA OVER OHIO RECEIVED DURING THIS REPORTING PERIOD

Date, 72 & 73	Time	Area	Quality Comments*
		TRACE 1	
Dec. 07	15362	NE Ohio and Pennsylvania	Very poor
Dec. 07	15364	Eastern Ohio	Excellent
Dec. 07	15371	SE Ohio and 90% West Virginia	Poor
Jan. 12	15355	NE Ohio and Pennsylvania	Good
Jan. 12	15362	Eastern Ohio and Pennsylvania	Good
Jan. 12	15364	SE Ohio and 90% West Virginia	Good
Feb. 17	15362	NE Ohio, Lake Erie, & Pennsylvania	Very good
Feb. 17	15365	East Ohio, West Virginia, & Penn.	Very good
Feb. 17	15371	Southern Ohio and West Virginia	Good
Feb. 17	15374	West Virginia	Very good
		TRACE 2	
Jan. 13	15413	NE Ohio, Lake Erie, and Cleveland	Good
Jan. 31	15415	NE Ohio, Lake Erie, and Cleveland	Very good
Jan. 31	15422	East of Columbus	Very good
Jan. 31	15424	SE Ohio and West Virginia	Very good
Jan. 31	15431	South from Ohio River boot	Good
Feb. 18	15421	NE Ohio, Lake Erie, and Cleveland	Very good
Feb. 18	15423	East of Columbus	Good
Feb. 18	15430	SE Ohio and Kentucky	Good
Feb. 18	15432	South from Ohio River boot	Fair
		TRACE 3	
Nov. 21	15474	NW Ohio, Lake Erie, and Toledo	Very poor
Nov. 21	15481	Columbus and SW Ohio	Very poor
Nov. 21	15483	Southern Ohio and Kentucky	Very poor
Dec. 27	15480	NW Ohio	Very poor
Dec. 27	15482	Southern Ohio and Kentucky	Very poor
Jan. 14	15481	Southern Ohio and Kentucky	Good
Feb. 01	15480	NW Ohio and Lake Erie	Very poor
Feb. 01	15474	NW Ohio	Very poor
		TRACE 4	
Dec. 28	15541	SW Ohio, Indiana, and Kentucky	Very good
Jan. 15	15533	Western Ohio and Eastern Indiana	Very poor
Feb. 02	15532	Western Ohio and Eastern Indiana	Very poor
Feb. 02	15535	SW Ohio, Indiana, and Kentucky	Very poor
		TRACE 5	
Nov. 23	15591	Eastern Lake Michigan to Ohio	Very poor
Jan. 16	15584	Eastern Lake Michigan to Ohio	Good

* Quality relates to general cloud cover condition over area covered by satellite photography.

TABLE II. MULTISPECTRAL COLOR COMPOSITES RECEIVED IN RESPONSE TO SPECIAL REQUEST

Date, 1972	Time	Area
		TRANSPARENCIES
Sep. 28	15465	Toledo and Detroit
Oct. 15	15415	East and central Ohio
		PRINTS
Sep. 27	15465	Toledo and Detroit
Aug. 21	15361	Southeastern Ohio and West Virginia
Sep. 09	15420	Southeastern Ohio and Kentucky

mounted in glass holdings or on a film roll with motor drive. Colored and neutral density filters may be switched in or out from the operator panel to make possible a great variation of enhanced imagery. (Twelve color and 20 density variations per channel or 960 all together.)

B. Equipment Modification

Additional modifications have been made in the laboratory equipment to aid the analysis process. An auxiliary camera in parallel with the standard camera of the TV 32-color viewer (Spatial Data Corporation) has been aimed into the screen of the spectral color viewer, thus allowing alternate, near simultaneous viewing of imagery on the 32-color viewer or the Multispectral Model 25 viewer at identical scales. This arrangement permits density slicing of up to five images with density differences as small as .01 D.

Geological, land-use, physiographic, etc., maps have been photographed to ERTS scales on 70-mm color film rolls. These map transparencies are substituted for one of the four ERTS channels to provide a very efficient map overlay of the ERTS imagery on the Spectral Data viewer screen.

Seventy-millimeter and nine-inch ERTS imagery have been spliced together in chronological order. This arrangement has eliminated the handling and alignment problems of ERTS-1 imagery in the viewers.

The Spatial Data Color viewer is also being used in a stereo mode. By nearly overlapping two conjugate ERTS (or aircraft underflight) images, and by switching in a green and red filter in each channel, a stereo image may be observed through standard anaglyph viewing glasses.

Initial experiments with a projection mode of the Model 25 viewer has found that image magnifications of some 20X are readily achievable.

C. Photographic Laboratory

A Chromega color head enlarger is being used to make color composites from 70-mm and nine-inch positive transparencies. Diazo techniques are also used to make overlay materials from ERTS imagery.

D. Data Analysis Tasks

Among the more important analysis tasks performed during this reporting period was a strip-mining inventory of Harrison County, Ohio. ERTS-1 data showed a total stripped acreage of 47,472 acres which compared closely to the 49,064 acres estimated by the Ohio Department of Natural Resources as having been stripped in a period between 1914-1971. The paper "Resource Management Implications of ERTS-1 Data to Ohio" by David C. Sweet, Terry L. Wells, and George E. Wukelic presented at the March ERTS symposium (attached as an Appendix) describes in greater detail the results of the analysis.

The analysis was primarily performed with the Spatial Data 32-color viewer which has a built-in electronic planimeter. (A check on the accuracy of the results was also made with standard planimetry.) The imagery for the analysis was taken on October 15, 1972. Band Number 5 yielded the most usable data. The density intervals required to differentiate the features were $D_{min} = .07$.

A similar analysis was also performed on the 32-color viewer to determine the usefulness of ERTS-1 imagery to delineate urban land-use patterns. This effort is also further described in the above referenced paper. The analysis of land-use patterns required the use of smaller density intervals, i.e., $D_{min} = .03$.

Plans for data analysis tasks during the next reporting period include further examination of the applicability of ERTS data to sedimentation and pollution problems in Lake Erie in cooperation with Ohio EPA personnel, beginning land-use mapping in the Cleveland and Ohio Transportation Research Center sites, and the preparation of a more detailed demonstration product of the strip-mine inventory in Harrison County including additional details on methodology and accuracy.

III. DCS/DCP EFFORT

The two problems cited in our semiannual progress report have been reconciled. The antenna cable rupture was determined to have occurred in a severe wind storm, and was not due to vandalism. Station outage from this cause terminated on January 16, 1973. A new interface device was fabricated and installed, eliminating the 60-cycle interference problem. Five meteorological sensors (for air temperature, wind direction, wind speed, rainfall, and solar radiation) were interfaced with the DCP on February 28. The platform has been transmitting continuously since that date.

In the semiannual report the possibility of connecting the DCP to a completely mobile system was discussed. Detailed assessment of this concept has resulted in the decision to make no change in the installation. The factors which influenced this decision are: (1) cost; (2) the successful overcoming of the electromagnetic interference problem; and (3) the determination that no vandalism has been or is likely to be experienced at the present site, while it would be a major possibility at alternate sites. This decision, however, does not negate the desirability of a mobile system.

It is planned to interface the water quality sensors of the Schneider Robot Monitor and the available air quality sensors with the DCP during April.

IV. DATA UTILITY ASSESSMENT

A questionnaire is being prepared for distribution to those state personnel who have Ohio-ERTS Data User Handbooks. This questionnaire will be used in determining the uses and usefulness of ERTS data.

V. SIGNIFICANT RESULTS

None this reporting period.

VI. MISCELLANEOUS

Mr. George Wukelic and Mr. Joachim Stephan of BCL and Mr. Terry Wells attended the ERTS-1 Symposium held by NASA at the Sheraton Motor Inn in New Carrollton, Maryland, on March 5-9. Mr. Wukelic presented a paper entitled "Resource Management Implications of ERTS-1 Data to Ohio", by David C. Sweet, Terry L. Wells, and George E. Wukelic. A copy of this paper is attached as an Appendix to this report.

In addition to this, we plan to present a paper on the Ohio-ERTS effort at the symposium on "Management and Utilization of Remote Sensing Data", sponsored by the American Society of Photogrammetry at the EROS Program Data Center on October 29-November 2, 1973.

During this reporting period ERTS imagery display boards were constructed and distributed to the various state agencies participating in the Ohio-ERTS program. The boards contain 40" x 40" enlargements of ERTS imagery on Ohio, assorted annotated enlargements, and color composite samples.

APPENDIX

RESOURCE MANAGEMENT IMPLICATIONS OF
ERTS-1 DATA TO OHIO

by

David C. Sweet and Terry L. Wells
State of Ohio -- Department of Economic
and Community Development

and

George E. Wukelic
Battelle Columbus Laboratories

Paper Presented at
SYMPOSIUM ON SIGNIFICANT RESULTS OBTAINED FROM ERTS-1
New Carrollton, Maryland
March 5-9, 1973

RESOURCE MANAGEMENT IMPLICATIONS OF ERTS-1 DATA TO OHIO

David C. Sweet and Terry L. Wells
State of Ohio -- Department of Economic and Community Development

and

George E. Wukelic
Battelle Columbus Laboratories

ABSTRACT

Initial experimental analysis of ERTS-1 imagery has demonstrated that remote sensing from space is a means of delineating and inventorying Ohio's strip-mined areas, detecting power-plant smoke plumes, and providing the data necessary for periodically compiling land-use maps for the entire state. This paper summarizes the nature and extent of these problems throughout Ohio, illustrates how ERTS data can contribute to their solution, and estimates the long-term significance of these initial findings to overall resource management interests in Ohio.

1. INTRODUCTION

NASA has provided the State Government of Ohio, on behalf of a number of its agencies* and assisted by Battelle Memorial Institute's Columbus Laboratories, with the opportunity to participate in the ERTS-1 program as a multidisciplinary user-investigator concerned with evaluating the state resource management implications of ERTS-1 data. This symposium has been organized to publicize significant results thus far obtained from ERTS-1. In this connection I would like to report first on what we feel is our most significant result to date. This is the swiftness with which remote sensing from space has captured the interest and confidence of potential state and local user groups, in spite of their limited previous experience in applying remote sensing technology. Moreover, significant progress toward demonstrating state-level utility has occurred. However, state needs for larger scale imagery and thermal infrared data for many applications are much in evidence. While in many cases our application findings and potential benefits are not directly translatable to other states, we nonetheless feel confident that the promise of ERTS will spread throughout the nation, insuring adequate user support for continuing orbital survey missions.

* Department of Economic and Community Development (Lead Agency)
Department of Natural Resources
Department of Transportation
Ohio Environmental Protection Agency

2. PRELIMINARY RESULTS

Although clouds have been a continuing problem, usable ERTS MSS imagery has been acquired for almost the entire state. However, the current availability of usable repetitive data is limited to portions of eastern Ohio. For imagery analysis and interpretation we are utilizing manual electro-optical image analysis techniques (multispectral and density/color viewers). These have been equally effective in visually demonstrating ERTS potentialities, accommodating real-time problem solving exercises involving technical and planning specialists, and generating sample ERTS data application products for subsequent utility assessment. The status of and state interest in our analytical program efforts are briefly summarized in Table I. Further discussion is limited to areas wherein ERTS data utility has definitely been demonstrated.

TABLE I. STATUS OF MAJOR ERTS DATA APPLICATION CANDIDATES UNDER EXAMINATION IN OHIO

Application Area	State Need	Potential State Value
	Utility Feasibility Demonstrated	
Strip mining	> 1/4 million acres affected	Help implement 1972 strip-mine law
Land use	Multiagency priority problem	Provide periodic statewide views of major land-use changes
Air quality	New Ohio EPA interest	Test computer model
Mapping	Current maps needed at all agency levels	Prepare photo base maps
	Utility Feasibility Under Study	
Sanitary land fills	> 1,400 illegal sites estimated	Detect illegal and/or new sites
Flood plains	50 % of Ohio cities subject to flood damage	Help define and enforce statewide regulatory law
Outdoor recreation	50 state parks exist--major expansion program underway	Help select new sites
Lake Erie	Unusual high water level posing severe erosion and flood hazard problems	Support Operation Foresight

A. Strip-Mine Reclamation Planning and Monitoring Implications

In April 1972, responding to overwhelming public sentiment, the Ohio Legislature passed legislation placing very stringent controls on strip mining in the state. This law places many new reclamation requirements on the operator, requires extensive preplanning of strip-mine operations, and gives the state the power to deny licenses to strip mine under certain conditions. The implementation of this law is a tremendous task which as yet hasn't been totally effected.

The state anticipates that ERTS data will prove useful in several ways in implementing the law. Initially, there is a need for an inventory and map of all strip-mined land to support reclamation planning activities, as an accurate and recent inventory in a readily available form does not exist. Information is especially scanty on land stripped before 1948, when Ohio passed its first strip-mine legislation.

As can be seen in Figure 1, ERTS photography is quite responsive to detecting surface-mining operations and reclamation efforts. This ERTS-1 scene of southeastern Ohio taken on August 21, 1972, shows an 8-mile long strip-mined area in which the Big Muskie is operating. Ground truth confirms that the dark square in the center of the stripped area was the location of the Big Muskie at the time. Figure 2 illustrates how well ERTS strip-mine imagery compares with aircraft photography. This photo shows a very small strip-mined area near Zaleski, Ohio. The satellite imagery has been magnified over 140 times to match the 1:24,000 scale routinely used in planning and map preparation.

With the ability to identify strip-mined areas established, an attempt was made to inventory and map the strip-mined areas of one Ohio county. Figures 3 and 4 show the distribution of stripped and unreclaimed land for Harrison County as displayed in an 32-color viewer enlargement of ERTS-1 MSS band 5 imagery. Area calculations correspond quite favorably to Department of Natural Resources (DNR) data. ERTS-1 data showed a total stripped acreage of 18.4 percent (or 47,472 acres) as compared to 19.01 percent (or 49,064 acres) for DNR. For unreclaimed acreage the figures were 6.2 percent for ERTS-1 and 6.8 percent for DNR. Comparison with aircraft data and on-site visitations are planned to further substantiate the accuracy of the inventory before proceeding with a 23 county survey of strip-mined areas in southeastern Ohio.

The current effort is to determine the extent to which ERTS multidate data can aid in enforcing the reclamation provisions of the strip-mine law. Under the law a strip-mine operator is required to commence backfilling, grading, and resoiling within three months after removal of overburden. Planting of vegetation must take place no later than the next appropriate season. With present ERTS resolution capabilities, it is doubtful that backfilling efforts can be monitored to the extent

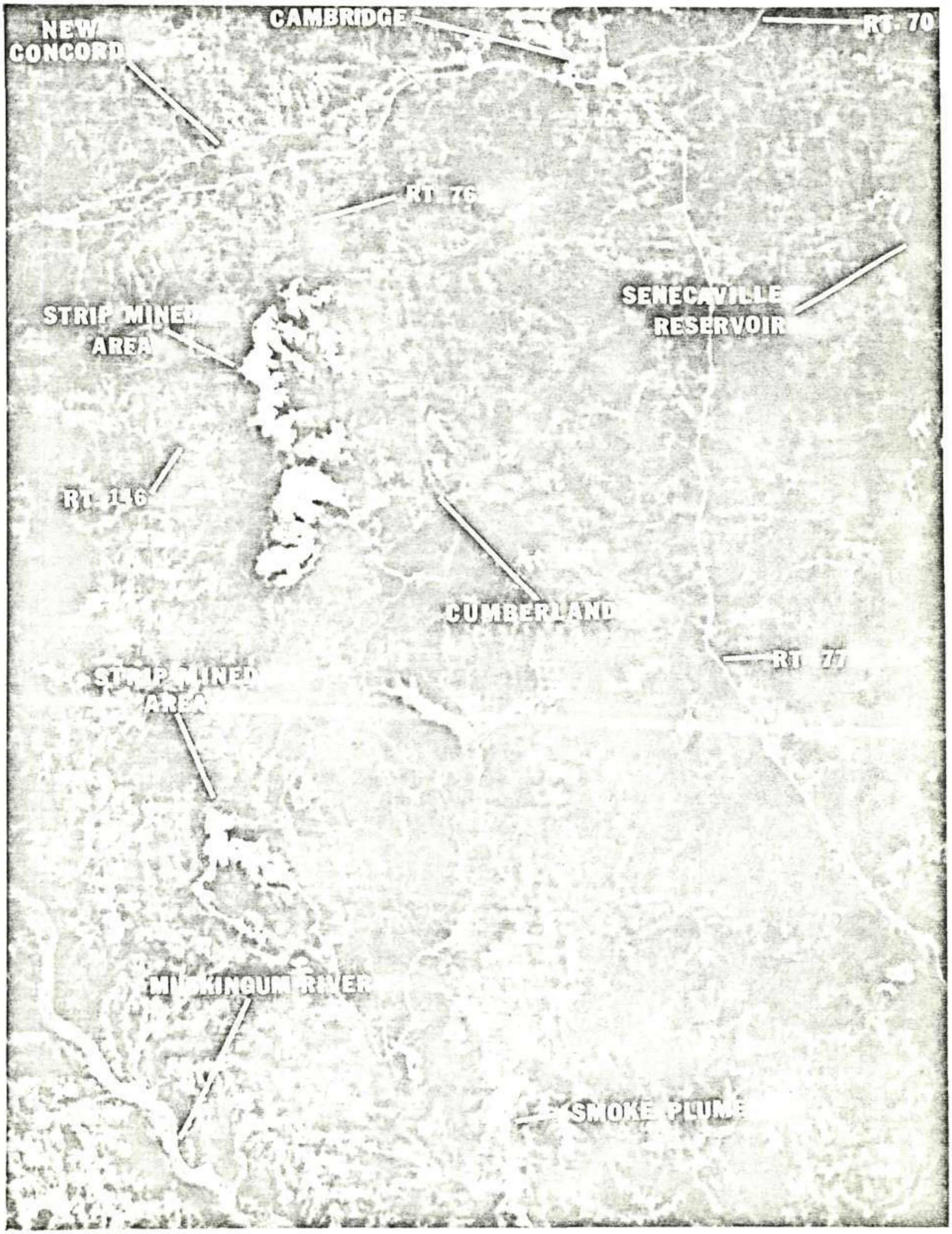

Fig. 1. Enlargement of ERTS MSS Band 5 Imagery (21 Aug 72) Showing Ohio Strip-Mine Areas.

Reproduced from best available copy.

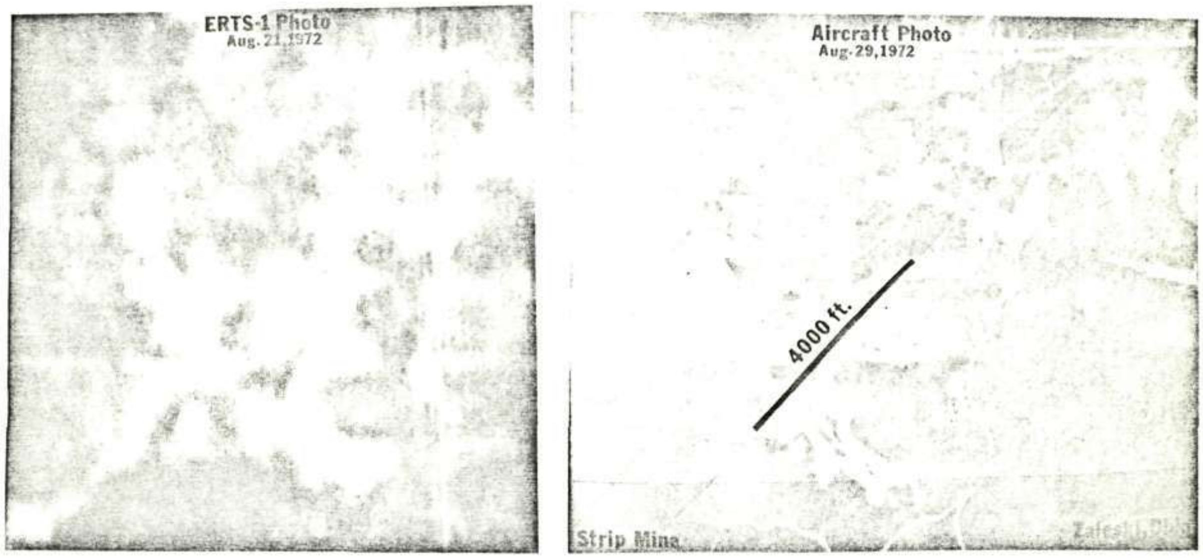

Figure 2. Comparison of ERTS-1 and Aircraft Photos of Strip-Mine Area Near Zaleski, Ohio. (Comparison Made at a Scale of 1:24,000.)

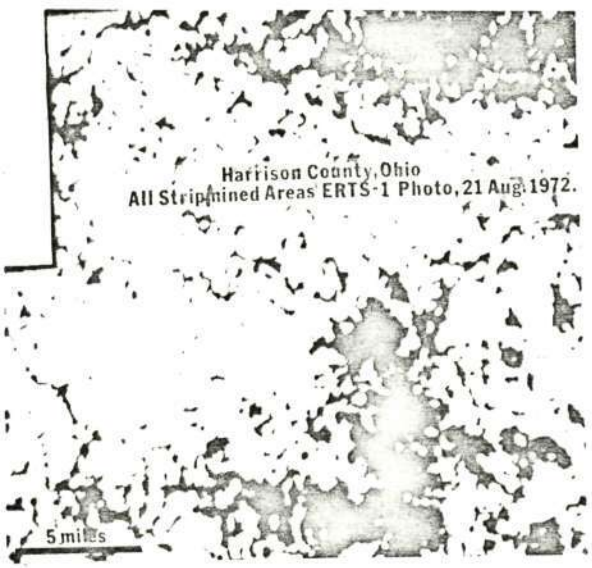

Fig. 3. Black Areas Represent Total Strip-Mined Areas of Harrison County, Ohio. (ERTS Imagery as Displayed on 32-Color Viewer.)

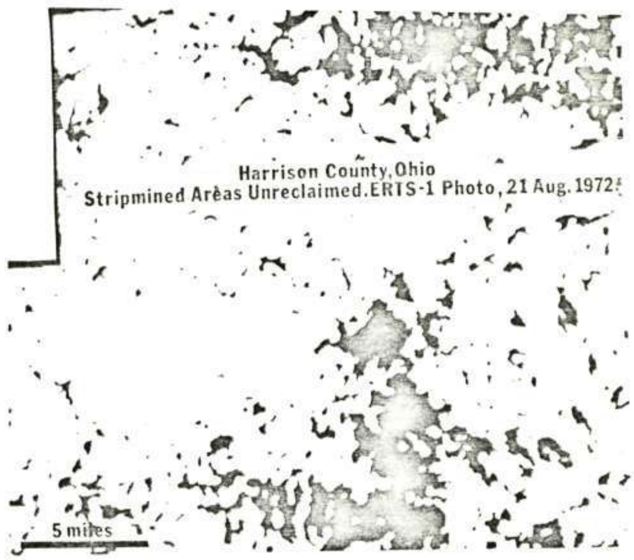

Fig. 4. Black Areas Represent Unreclaimed Strip-Mine Areas of Harrison County, Ohio. (ERTS Imagery as Displayed on 32-Color Viewer.)

Reproduced from best available copy.

necessary for regulatory purposes. However, ERTS data will be useful in determining if lasting reclamation has been accomplished. In many cases the initial vegetative cover appears healthy at first, but after several years a change in hydrologic conditions may cause acid water to reappear and destroy the vegetation. This capability will permit more accurate judgments in issuing permits and releasing bonds posted by strip-mine operators.

B. State Land-Use Planning Implications

Support for a national land-use policy has grown steadily stronger and indications are that Congress will soon act on one of the several land-use bills presently under consideration. One of the common features of these bills is that states will be required as part of their land-use planning process to include "the preparation and continuing revision of a statewide inventory of the land and natural resources of the State". This is one area in which orbital survey data will help multiagency efforts in Ohio. Specifically, ERTS imagery will provide a current and comprehensive data base illustrating the inter-relationships of static and dynamic natural and cultural surface features.

Thus far we have established that mapping of natural and cultural features from ERTS imagery can be done with confidence to scales of larger than 1:125,000. Figure 5 provides examples of our pilot land-use mapping efforts in the over 500 square-mile Columbus/Franklin County area. These scenes, taken from the Spatial Data 32-color viewer, show the various major land-use features discernible: total urban coverage, urban growth that has occurred principally over the last 12 years, and distribution of tree stands, parks, and woods. Aerial photo index sheets have been found quite valuable in verifying the extent and geometry of the land-use patterns generated.

Our current objective is to attempt to update the general 1:500,000 scale land-use map of Ohio which was completed in 1967 at a cost of approximately a quarter million dollars. If successful, at least for USGS recommended Level I land-use categories, state planners will have a relatively inexpensive and periodic information base for making general land-use decisions. This information will not replace the need for more detailed studies in specific areas; and therefore, any improvement of resolution in future satellite survey missions will increase the value of the information provided.

C. Environmental Quality Implications

An Ohio Environmental Protection Agency was established in October 1972 to consolidate environmental quality protection activities in Ohio. It has prepared the implementation plan required by the Federal Clean Air Act to meet standards set by the Federal EPA. As part of this plan,

Reproduced from
best available copy.

Figure 5. Illustrations of Urbanized Land-Use Features
Discernible on ERTS-1 Photography.

officials are required to establish emission limitations for all significant state pollution sources. In an effort to determine the effect of pollution sources on air quality, the state has developed an air movement model. The demonstrated ability of ERTS to detect major smoke plumes on a repetitive basis will be utilized in combination with meteorological data to evaluate and verify this model. ERTS imagey may also reveal the extent to which smoke plume confluence is occurring.

Although the prime interests of state EPA personnel generally associate with thermal infrared data (unfortunately unavailable from ERTS-1), some preliminary assessments have been made as to the utility of ERTS for detecting illegal and/or selecting new sanitary landfill sites and monitoring Lake Erie sedimentation. Ohio EPA interest and confidence in applying remote sensing technology are manifest in a grant request submitted to enable the agency to purchase and operate a fully equipped remote sensing aircraft.

D. Mapping Implications

Enlargements of bulk processed ERTS MSS imagery have been found to match very closely most standard map scales in common use in Ohio. The resource management implications from the standpoint of preparing up-to-date thematic maps are obvious. Currently, 1:250,000 mosaics of Ohio in two MSS bands (5 and 7) are being prepared by the Department of Transportation. These mosaics will serve as photo base maps for state transportation research and planning.

3. SUMMARY AND RECOMMENDATIONS

Obviously, Ohio is optimistic about the resource management application opportunities emerging from initial ERTS imagery analysis. Hopefully, several demonstrated applications will mature into routine statewide planning functions, and additional application possibilities will surface. The economic and operational implications of these early results remain to be determined. Equally important is that some user enthusiasm is being lost because of the unavailability of thermal infrared data. Also, many application candidates proposed by state user agencies but found to be marginal or inappropriate based on current ERTS data capabilities, could become feasible were higher resolution imagery provided. Accordingly, from a state viewpoint, NASA's recent decision to incorporate a thermal infrared capability in the ERTS-B mission is sound and we suggest also that serious consideration be given to modifying the mostly redundant RBV into a system for providing larger scale imagery on a repetitive but longer term basis.